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Residence Near a Major Road and Respiratory Symptoms in U.S. Veterans

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Abstract

Background—There is evidence that exposure to motor vehicle exhaust is associated with respiratory disease. Studies in children have observed associations with wheeze, hospital admissions for asthma, and decrements in pulmonary function. However, a relationship of adult respiratory disease with exposure to vehicular traffic has not been established.

Methods—We studied a sample of U.S. male veterans drawn from the general population of southeastern Massachusetts. Information on respiratory symptoms and potential risk factors was collected by questionnaire. We assessed distance from residential addresses to major roadways using geographic information system methodology.

Results—Adjusting for cigarette smoking, age, and occupational exposure to dust, men living within 50 m of a major roadway were more likely to report persistent wheeze (odds ratio [OR] = 1.3; 95% confidence interval [CI] = 1.0–1.7) compared with those living more than 400 m away. The risk was observed only for those living within 50 m of heavily trafficked roads (≥10,000 vehicles/24 h): OR = 1.7; CI = 1.2–2.4). The risk of patients experiencing chronic phlegm while living on heavily trafficked roads also increased (OR = 1.4; CI = 1.0–2.0), although there was little evidence for an association with chronic cough. This association was not dependent on preexisting doctor-diagnosed chronic respiratory or heart disease.

Conclusions—Exposure to vehicular emissions by living near busy roadways might contribute to symptoms of chronic respiratory disease in adults.

Keywords

respiratory symptoms; traffic; GIS; air pollution; mobile sources; adults

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Particulate air pollution measured at central monitoring stations has been strongly associated with hospital admissions and cardiopulmonary mortality.[1–4] Motor vehicle exhaust is a source of fine particles, nitrogen oxides, and various hydrocarbons. In a recent mortality study, variations in mortality were related specifically to automobile exhaust, suggesting the potential adverse health effects of this source.[5]

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If motor vehicle exhaust is associated with respiratory illness, it would be expected that exposure would also produce respiratory disease symptoms such as cough, phlegm, and wheeze. Alternatively, the only subjects affected might be those already ill with chronic respiratory diseases or other subgroups (such as children).

There have been numerous population-based studies investigating the health effects of exposure to traffic. At least 15 of these studies[6 –20] have focused on children. Exposure has typically been based on the relation between the child's residence and traffic density on a nearby roadway. Positive associations with wheeze, hospital admissions for asthma, and decrements in pulmonary function have been reported in most studies. Only 2 studies have included adults from the general population. In Japan, Nitta and coworkers[21] found elevated odds ratios for chronic cough and chronic phlegm in women living within 20 –50 m of a busy roadway, with the risk of chronic wheezing not consistently elevated. Oosterlee,[13] in The Netherlands, found no relation between residence near a busy street and respiratory symptoms. Some studies in occupational cohorts have suggested that exposure to exhaust fumes could result in an excess of respiratory symptoms. These studies have mainly been conducted in tunnel and bridge workers,[22,23] policemen,[24] street cleaners,[25] bus garage workers,[26,27] and miners.[28–30] Although workers have the option of leaving work if symptoms or illness develops, exposures based on residence are not so easily avoided.

To assess the relation between exposure to motor vehicle exhaust and respiratory symptoms in adults, we studied a sample of U.S. veterans drawn from the general population of southeastern Massachusetts. Information on respiratory symptoms and potential risk factors were collected by questionnaire, and residential addresses were related to distance from and traffic density of major roadways.

METHODS

Population

Between 1988 and 1992, a 2-page health questionnaire was mailed to 5654 male veterans in southeastern Massachusetts. These were men who were eligible for medical care but had not been treated in a Veterans Affairs Medical Center in the year preceding the mailings. The purpose of the survey was to obtain information regarding the prevalence and potential risk factors of respiratory symptoms and chronic illnesses in this population. Addresses were obtained from the Department of Veterans Affairs for veterans residing in selected zip codes near the Brockton, Massachusetts, Veterans Affairs Hospital. All eligible veterans in these locations were included in the questionnaire mailing. In a cover letter, subjects were asked to participate in a respiratory health survey. Approval for this investigation was provided by the Institutional Review Boards of the VA Boston Healthcare System and Brigham and Women's Hospital.

After 2 mailings, the overall response rate was 58% (2985 of 5113); 412 questionnaires were returned as a result of incorrect addresses and 129 were returned with death notifications. There were too few women or nonwhite respondents for analysis. We therefore excluded 90 subjects who were nonwhite, female, or were missing race or sex information. An additional 29 were excluded as a result of a missing date of birth, leaving 2866. We further excluded 3 individuals who did not live in the 4 counties represented by the majority of the cohort population (Barnstable, Bristol, Norfolk, and Plymouth), 159 whose address was a post office box, 3 in a penal institution, and 73 who had insufficient address information, leaving a study population of 2628. (A map showing the geographic distribution of respondents is available with the electronic version of this article at www.epidem.com.)

Questionnaire

Questions were selected from the American Thoracic Society DLD-78 questionnaire. These included questions on duration of cigarette smoking, average number of cigarettes smoked, and report of cough, phlegm, and wheeze.[31] Subjects also completed a checklist of medical conditions, and indicated whether a doctor had confirmed each condition. Conditions included chronic bronchitis, asthma, emphysema, angina, heart attack, and other heart diseases. Occupational exposure to dust was assessed by the question, "Have you ever worked in a dusty job (yes or no)?" Subjects were asked to indicate the year these exposures started and stopped, the type of dust exposure, and the intensity of exposure (mild, moderate, or heavy). Information regarding usual job title, employment status, and years of education was obtained.

Assessment of Exposure to Motor Vehicle Exhaust

Exposure to motor vehicle exhaust was defined by the distance from each residential address at the time of the questionnaire mailing to the nearest major road and by the average daily traffic count for that road. We linked each address to a current street network layer obtained from the U.S. Census using the Geographic Information System (GIS) software ArcGIS (ArcGIS. 8.1, ESRI, Redlands, CA). Department of Transportation classifications for major roads were obtained from a layer provided by MassGIS (Executive Office of Environmental Affairs, Boston, MA, 2000). Before mapping, all addresses were processed through the U.S. Postal Service ZIP Code Plus Four web site to account for changes in U.S. postal zip codes between the time of mailing and the time of analysis. The shortest distance (in meters) between each address and the centerline of the major road was calculated using ArcGIS with a resolution of 3 m. Geocoding and nearest major road assignment were manually checked for all subjects.

Average daily traffic counts for all vehicle types were obtained from the Massachusetts Central Transportation Planning Staff (Boston Metropolitan Planning Organization, Boston, MA, 2000) and Geographic Data Technologies, Inc. (Lebanon, NH, 2000). These values are calculated mainly using data obtained from permanently located traffic counters embedded under the road. The remaining values are from temporary traffic counters placed across the roadway by state or local agencies. Average daily traffic counts are defined as the average number of vehicles per weekday based on an average of the counts obtained throughout the year. When available, mean average daily traffic counts for 1988 –1992 were assigned to each major road. If these years were unavailable, mean average daily traffic between 1982–1987 and 1993–1996 were used. If traffic was not measured during these time periods, the average daily traffic was extrapolated based on the average of other roads of the same road class and urban or rural designation in that county. An extrapolated value for average daily traffic was used in 17% of the study subjects. This extrapolation algorithm worked well; for measured roads, the actual and extrapolated values were highly correlated ($r = 0.83$).

Statistical Analysis

Outcome was defined by self-report of symptoms. "Chronic cough" was cough on most days for 3 consecutive months or more during the year. "Chronic phlegm" was phlegm on most days for 3 consecutive months or more during the year. "Persistent wheeze" was wheezing with a cold and occasionally apart from colds, or on most days or nights. We used a multiple logistic regression model to examine the association of exposure to motor vehicle exhaust with each respiratory symptom independently and to adjust for potential confounders. Exposure to motor vehicle exhaust was examined in 2 ways, by distance to the closest major road and by the average daily traffic count for that road. We grouped distances to the major road into 6 categories: ≤50, >50 to 100, >100 to 200, >200 to 300, >300 to 400, and >400 m. We considered average traffic count as a continuous variable, as a variable divided into quartiles, and as a dichotomous variable based on the median (±10,000 vehicles per day). For our primary analyses, we used all available data; we also performed sensitivity analyses restricting the

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population to those with average daily traffic counts for the years 1984 –1996 and further for those with counts for 1988 –1992. Finally, we created an interaction term of distance with average daily traffic counts. Odds ratios (OR) and 95% confidence intervals (CI) are presented. All analyses were conducted using SAS software (version 6.12, SAS Institute, Cary, NC).

Logistic regression models were examined for potential confounding by age, smoking, occupational dust exposure, known biologically important predictors of respiratory symptoms, and job category, employment status, education, urban residence, and socioeconomic status. Age was calculated as the year of questionnaire return minus the year of birth and modeled as a continuous variable. A smoker was defined as smoking 20 or more packs of cigarettes in a lifetime or more than 1 cigarette per day for 1 year. Smokers were defined as "current smokers" if they reported smoking cigarettes within the last month. Indicator variables for current smoker and former smoker, as well as continuous variables for current number of cigarettes per day and years since quitting smoking, were considered in the models.

Usual job was coded based on the 1980 Occupational Classification System of 3-digit job classifications[33] and grouped by occupational category (Table 1). Current employment status (unemployed, employed, retired) was also evaluated. Exposure to occupational dust was modeled in the following ways: (1) indicator variable for ever/never exposed; (2) intensity of exposure (mild, moderate, heavy); (3) duration of exposure (in years); (4) type of dust (fumes, inorganic, organic, metals, dirt, and other dusts); and (5) years since last dust exposure. Education was grouped as less than high school, completion of high school, and greater than high school.

Each address was classified as either urban or rural based on standard U.S. Census definitions for 1990.[34] As measures of socioeconomic status, we used individual block group level variables from the 1990 U.S. Census for median housing value, median monthly rent, median yearly house-hold income, per capita yearly income, number of persons in poverty, and percent in poverty. These variables were modeled both as continuous variables, and as above and below the median.

Because the occurrence of respiratory symptoms might be influenced by disease status, we evaluated comorbid respiratory and cardiac conditions both as confounders and effect modifiers. We defined ischemic heart disease as having had doctor-diagnosed angina or myocardial infarction, and respiratory disease as either doctor-diagnosed asthma or chronic obstructive pulmonary disease (chronic bronchitis or emphysema). We created interaction terms of disease with distance to the major road dichotomized by 50 m and by traffic density using the median of 10,000 vehicles a day. These were evaluated in separate models.

RESULTS

Cohort Description

The mean age of the men in the final analytical population was 60.6 ± 12.8 years (mean ± standard deviation). The distributions of smoking, education, and occupational characteristics are presented in Table 1. Only 20% of the total population were never-smokers. A minority of subjects reported that their usual job was professional (21%), and 55% of the respondents were retired at the time of the questionnaire. Eighty-four percent of the population lived in an urban area. The distribution of residential addresses ranged from 0.25–3165 m to the nearest major road (Table 1), with a median distance of 191 m. The classifications of major roads included: class 1, limited access highways (7% of the addresses); class 2, multilane highways (1%); class 3, other numbered roads (43%); and class 4, major connector roads (48%). The mean average daily traffic count for class 1 roads was 42,592, for class 2 roads 13,566, for class 3 roads 12,076, and for class 4 roads 8643 vehicles per day. Daily traffic counts for all roads ranged from 193–95,654 vehicles per day (median, 9695). Data obtained for census block group median housing value (median, $143,100; interquartile range [IQR], $30,100); median monthly rent ($604; IQR, $207); median yearly household income ($40,223; IQR, $9388); yearly per capita income ($15,309; IQR, $2549); number of persons in poverty (239; IQR, 237); and percent in poverty (4.7%; IQR, 3.9%) indicated that the range of variability of the socioeconomic variables was small within the geographic areas selected for study. Housing costs and income data in this region are below the median value for the rest of Massachusetts in 1990 (1990 U.S. Census).

The prevalence of persistent wheeze, chronic cough, and chronic phlegm was 31%, 22%, and 27%, respectively (Table 1). The prevalences of doctor-confirmed chronic respiratory diseases and heart diseases are also presented in Table 1.

Distance From Roadway and Traffic Volume

Unadjusted for other factors, subjects living within 50 m from a major roadway were more likely to report persistent wheeze compared with subjects living more than 400 m away (OR = 1.33; 95% CI = 1.05–1.70; Table 2). For subjects living between 50 and 400 m, the ORs for persistent wheeze were not substantially elevated (Table 2). Subjects living within 50 m from a major roadway also were more likely to report chronic cough and chronic phlegm (Table 2). After adjustment for age, cigarette smoking, and occupational dust exposure (Table 3), the OR of reporting persistent wheeze for subjects living within 50 m from a major roadway remained virtually unchanged (OR = 1.31; 95% CI = 1.00 –1.71), whereas the associations of distance with chronic cough and chronic phlegm were weakened (Table 3).

For subjects living within 50 m of a major roadway the median traffic volume was 9351 vehicles per day (IQR; 7704 –12,995; minimum, 1012; maximum, 83,770 vehicles per day). After adjusting for smoking, age, and occupational dust exposure, persistent wheeze was elevated for subjects living within 50 m of a major road with 10,000 or more vehicles per day, but not for those with lower traffic counts (Table 4). A similar pattern was observed for chronic phlegm. Similar results were obtained excluding subjects with extrapolated values for traffic counts (data not shown).

Effect of Chronic Diseases

Subjects with chronic respiratory disease (doctor-confirmed asthma, chronic bronchitis, or emphysema) were more likely to report persistent wheeze (OR = 8.0; 95% CI = 6.1–10.5), chronic cough (OR = 3.5; 95% CI = 2.6 – 4.6), and chronic phlegm (OR = 3.7; 95% CI = 2.9 – 4.8), adjusting for age, smoking, occupational dust, and distance from a roadway. After adjustment for chronic respiratory disease, the OR for persistent wheeze for subjects living within 50 m of a major roadway (OR = 1.4; 95% CI = 1.0 –1.8; Table 4) and the OR for subjects within 50 m and with traffic counts of ≥10,000 vehicles per day (OR = 1.8; 95% CI = 1.3–2.5) were similar to values without this adjustment. The ORs for chronic cough and phlegm were also similar and not substantially increased. A history of heart disease was also a risk factor for all 3 symptoms (details not shown); but when heart disease was included in models with chronic respiratory disease, it was no longer a predictor. Separate logistic regression analyses were conducted for subjects with and without chronic respiratory or heart disease. These analyses did not suggest that subjects with these chronic diseases were more likely to report symptoms if they lived within 50 m of a major roadway, even if there were 10,000 vehicles or more per day on these roads.

Other Potential Confounders or Effect Modifiers

Current cigarette smoking was the strongest risk factor for respiratory symptoms, with ORs in the range of 5–7. Occupational dust exposure was associated with an approximately 2-fold

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elevated risk (Table 3). The OR for each symptom increased based on the number of cigarettes smoked per day, and decreased depending on the number of years of smoking cessation (details not shown). Alternative regression models that included number of cigarettes smoked daily and years since quitting smoking did not substantially influence the relationship between distance from a major roadway and the odds of each respiratory symptom. Analyses conducted in never-smokers, adjusted for age and occupational dust exposure, resulted in an OR of 2.08 (95% CI = 1.02– 4.22; Table 4) for persistent wheeze for subjects living within 50 m of a major roadway. The equivalent ORs for former and current smokers were lower (Table 4). These results suggest that never-smokers might have a greater risk of persistent wheeze associated with living within 50 m of a roadway.

Analyses were also conducted in subjects with and without occupational dust exposure, adjusting for age and smoking (data not shown). The OR for persistent wheeze in subjects with occupational dust exposure and living within 50 m of a roadway was 1.44 (95% CI = 1.04 – 2.11). This was slightly greater than those without dust exposure (OR = 1.11; 95% CI = 0.75– 1.65). Dust intensity, type of dust, duration of dust exposure, and time since last dust exposure were also considered as confounders. These variables did not change the relationship between each respiratory symptom, distance from a roadway, and traffic volume. Indicators of socioeconomic status added separately as continuous variables to the main regression model were not significant predictors of persistent wheeze or chronic phlegm. Subjects with lower socioeconomic status were more likely to report chronic cough (data not shown). However, these variables did not change the association of chronic cough with residence near a roadway. There was also no evidence of confounding or effect modification by educational attainment, job category, and urban or rural residence.

DISCUSSION

We report a relation between respiratory symptoms in adults and residence near a major roadway. After adjustment for cigarette smoking, occupational dust exposure, and age, subjects with a residential address within 50 m of a major roadway had approximately a 30% excess risk of reporting persistent wheeze compared with subjects living 400 m or more away. If the roadway had an average daily vehicle count of 10,000 or more vehicles, the OR was 1.71 (95% CI = 1.22–2.40). Although chronic cough was more likely to occur in subjects living closer to a major roadway, this association was attenuated after adjustment for cigarette smoking and occupational dust exposure. Subjects living within 50 m of a major roadway with an average daily traffic count of 10,000 or more vehicles per day had an elevated risk of chronic phlegm (OR = 1.40; 95% CI = 0.97–2.02). Medical conditions such as chronic respiratory disease or heart disease were not associated with a greater risk of respiratory symptoms. It is also possible that subjects who were nonsmokers or who had occupational dust exposure had the greatest risk of persistent wheeze if living within 50 m of a roadway.

Although the levels of exhaust constituents are not known in this study, measurements in the literature indicate that levels of fine particles and nitrogen oxides are greatest near roadways with the most traffic volume.[13,20,21,35] In a study in Nottingham, England, exhaust constituents were reported to decrease exponentially from the curbside to a distance of 150 m.[7] In a more recent study from Los Angeles, particle number also decreased exponentially.[36] Ultrafine particle number and black carbon concentration decreased 60% within 100 m and then approached background levels. In contrast, in a study in The Netherlands, indoor measurements of nitrogen dioxide and black smoke (an index of diesel traffic) were not related to distance from the roadway in schools between 35– 645 m away.[14] However, these measurements were related to traffic density. Although nitrogen dioxide levels might reflect traffic emissions, published measurements have varied considerably and have not reflected differences in traffic volume across studies conducted in Japan and The Netherlands.[13,21]

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Two studies of traffic exposure have included adults drawn from the general population. Oosterlee and coworkers[13] studied 1100 men and women in areas of high and low traffic density. The OR for chronic cough, chronic phlegm, and wheeze in adults living on busy streets were all near unity compared with those living in neighborhoods with little traffic. In Tokyo, 3 cross-sectional studies were conducted in 3 separate groups of 1500 women in 1979, 1982, and 1983. Adjusting for potential confounders, the odds ratios for chronic cough and phlegm were elevated in 1979 and 1983 for subjects living within 20 m of the roadway compared with others, and were elevated in 1982 for subjects living within 20 m and also between 20 and 50 m. For subjects living within 20 m from the roadway, the risk of chronic wheeze was also elevated in 1979 and 1982. The reason for the difference in the risk of wheeze between the earlier and later surveys is not apparent.

Results in occupational cohorts generally support these results. Evans and coworkers[23] reported an increase in prevalence of cough, phlegm, and wheeze with years of work in bridge and tunnel workers in New York City. Copenhagen street cleaners had more chronic cough and phlegm than workers unexposed to exhaust fumes,[25] as did traffic policemen in Thailand.[24] Some studies of miners and bus garage workers[23–30] indicate that there is a relation of work in a diesel-exposed job with cough and phlegm, and possibly wheeze, whereas others have not found this.[37,38]

The most consistent results have been in studies of children. Using GIS methodology, Venn and coworkers[7] found that the risk of wheeze among children in Nottingham, England, living within 150 m of a main road increased 8% for every 30 m closer in distance, with most of the risk being within 90 m of the road. Traffic flow in proximity to children's schools was not associated with wheeze in an earlier publication,[7,9] but traffic density was considered in 1-km grids, too large an area to reflect meaningful variations in personal exposure. In The Netherlands, a doubling of the risk of wheeze was reported in children living within 100 m of a roadway.[39] For children living within 300 m, measurements of truck density, but not automobile density, were related to lower values of pulmonary function.[14] In Munich, decrements in peak flow in children were directly related to measurements of automobile traffic volume and with an increased risk of recurrent wheeze.[12] Self-reports of truck volume were also related to wheezing[8,10] and recurrent respiratory illness.[11] Hospital admissions for asthma were more common in children living within 500 m of a roadway in Birmingham, U.K.[15] and was associated with greater traffic volume,[15,16] but such admissions were not found to be increased in a third study conducted in West London.[17] An association has also been found between ambient nitrogen oxides (whose major source are vehicle emissions) and asthma prevalence among Taiwan middle school students.[6]

Some studies have suggested a stronger association with diesel vehicles than gasoline.[14] In the majority of studies, including ours, it is not possible to separate vehicle type. In the United States during the study period, few light-duty vehicles were diesel-powered, and most of the traffic was attributable to gasoline-powered light-duty vehicles. The geographic area surveyed for this study had little land area (1.3%) used for industry that might serve as other sources of emissions (Executive Office of Environmental Affairs, Boston, MA, 2000).

A limitation of this study is the lack of information regarding duration of residence in each address, and information regarding home exposures to nitrogen oxides from cooking or heating. We also lack information regarding the health status of nonresponders. Nevertheless, the study results should be internally consistent. It is unlikely that residential distance is related both to respiratory symptoms and response rate. Because subjects who had not been treated in a VA hospital in the year preceding the mailing were not included, it is also possible that subjects likely to be sicker were excluded. Thus, if the effects of living near a roadway are real, we might have underestimated them.

The results of this study suggest that adults are at risk for persistent wheeze and possibly chronic phlegm if they live near a major roadway. The risk was not the result of chronic respiratory or cardiac disease. Additional work is needed in other populations to confirm this finding and to relate this increased risk to specific levels and types of emissions.

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TABLE 1

Characteristics of the Respondents to the Veterans Questionnaire Who Had Complete Exposure Information (N = 2,628)

Characteristic	N	%
Smoking		
Current	679	26
Former	1373	52
Never	536	20
Missing	40	2
Occupational dust		
Yes	1223	47
No	1261	48
Missing	144	5
Residential Designation		
Urban	2203	84
Rural	425	16
Education		
<12th Grade	706	27
12th Grade	1011	38
>12th Grade	858	33
Missing	53	2
Employment status		
Employed	996	38
Unemployed	144	5
Retired	1458	55
Missing	30	1
Usual job classification		
Managerial and professional	565	21
Technical, sales, administrative support	566	22
Service occupation	287	11
Agriculture, crafts, machine operators, transportation	877	33
Missing	332	13
Distance to major road (meters)		
≤50	602	23
>50–100	262	10
>100–200	486	18
>200–300	332	13
>300–400	234	9
>400	712	27
Respiratory symptoms		
Persistent wheeze	751/2,432	31
Chronic cough	522/2,393	22
Chronic phlegm	622/2,335	27
Chronic diseases*		
Asthma	143/2,094	7
COPD†	349/2,149	16
Asthma or COPD	409/2,151	19
Myocardial infarction or angina	475/2,255	21
Other heart disorders	312/2,067	15

* Self-report of doctor-confirmed disorders.

† Self-report of doctor-confirmed chronic bronchitis or emphysema.

TABLE 2

Association of Distance of Residence to the Nearest Major Road and Respiratory Symptoms; Unadjusted Logistic Regression Models

	Persistent Wheeze			Chronic Cough			Chronic Phlegm		
	No. of Subjects (N = 2,285)	**No. of Cases (N = 700)**	**OR (95% CI)**	**No. of Subjects (N = 2,243)**	**No. of Cases (N = 496)**	**OR (95% CI)**	**No. of Subjects (N = 2,201)**	**No. of Cases (N = 583)**	**OR (95% CI)**
Distance to road (meters)									
≤50	516	184	1.33 (1.05–1.70)	507	127	1.42 (1.08–1.86)	503	145	1.35 (1.04–1.75)
>50 to 100	229	61	0.92 (0.66–1.27)	225	44	1.03 (0.71–1.50)	215	56	1.11 (0.79–1.58)
>100 to 200	421	126	1.09 (0.84–1.41)	413	91	1.20 (0.89–1.62)	399	108	1.21 (0.92–1.61)
>200 to 300	294	84	0.97 (0.72–1.30)	286	62	1.16 (0.83–1.63)	285	74	1.15 (0.84–1.58)
>300 to 400	205	64	1.13 (0.81–1.58)	206	50	1.43 (0.99–2.06)	202	57	1.37 (0.97–1.94)
>400*	620	181	1.00	606	122	1.00	597	143	1.00

*Reference category.

TABLE 3

Association of Distance of Residence to a Major Road and Respiratory Symptoms; Logistic Regression Models Adjusted for Age, Smoking Status, and Occupational Dust Exposure

	Persistent Wheeze			Chronic Cough			Chronic Phlegm		
	No. of Subjects (N = 2,285)	No. of Subjects (N = 2,243)	OR (95%CI)	No. of Subjects (N = 2,243)	No. of Cases (N = 496)	OR (95% CI)	No. of Subjects (N = 2,201)	No. of Cases (N = 583)	OR (95% CI)
Age (10 years)			0.94 (0.87–1.02)			1.01 (0.93–1.10)			1.08 (0.99–1.17)
Smoking									
Current	586	302	4.73 (3.51–6.36)	592	265	6.76 (4.76–9.60)	580	270	5.20 (3.76–7.18)
Former	1220	318	1.71 (1.29–2.25)	1191	185	1.58 (1.12–2.23)	1176	252	1.61 (1.19–2.19)
Never*	479	80	1.00	460	46	1.00	445	61	1.00
Occupational dust exposure	1105	446	2.26 (1.87–2.74)	1086	314	1.92 (1.55–2.39)	1074	368	2.04 (1.67–2.50)
Distance to road (meters)									
≤50	516	184	1.31 (1.00–1.71)	507	127	1.24 (0.92–1.68)	503	145	1.18 (0.88–1.56)
>50 to 100	229	61	0.87 (0.61–1.25)	225	44	0.92 (0.61–1.39)	215	56	1.07 (0.73–1.56)
>100 to 200	421	126	1.11 (0.83–1.48)	413	91	1.21 (0.87–1.67)	399	108	1.24 (0.91–1.68)
>200 to 300	294	84	1.11 (0.80–1.54)	286	62	1.30 (0.90–1.87)	285	74	1.23 (0.87–1.73)
>300 to 400	205	64	1.19 (0.83–1.72)	206	50	1.34 (0.90–2.01)	202	57	1.32 (0.91–1.94)
>400*	620	181	1.00	606	122	1.00	597	143	1.00

* Reference category.

TABLE 4

Association of Residence Within 50 Meters of the Nearest Major Road and Respiratory Symptoms, in Selected Logistic Regression Models

Model	Persistent Wheeze			Chronic Cough			Chronic Phlegm		
	No. of Subjects (N = 2,285)	No. of Subjects (N = 2,243)	OR (95%CI)	No. of Subjects (N = 2,243)	No. of Cases (N = 496)	OR (95% CI)	No. of Subjects (N = 2,201)	No. of Cases (N = 583)	OR (95% CI)
Residence within 50 meters of major road*	516	184	1.31 (1.00–1.71)	507	127	1.24 (0.92–1.68)	503	145	1.18 (0.88–1.56)
Average daily traffic volume within 50 meters*									
≥10,000	297	96	1.71 (1.22–2.40)	294	75	1.29 (0.87–1.91)	293	80	1.40 (0.97–2.02)
<10,000	219	88	1.06 (0.77–1.46)	213	52	1.21 (0.85–1.72)	210	65	1.03 (0.74–1.45)
Adjusted for COPD and asthma*									
≤50 meters	516	184	1.37 (1.03–1.82)	507	127	1.23 (0.90–1.67)	503	145	1.17 (0.87–1.56)
Adjusted for heart disease*									
≤50 meters	516	184	1.34 (1.02–1.76)	507	127	1.26 (0.93–1.71)	503	145	1.19 (0.89–1.59)
≤50 meters to the nearest major road, in separate models stratified by smoking status†									
Never	89	21	2.08 (1.02–4.22)	85	7	1.13 (0.41–3.11)	84	13	1.17 (0.54–2.56)
Former	272	76	1.17 (0.80–1.70)	265	44	1.33 (0.83–2.13)	265	56	1.24 (0.81–1.90)
Current	155	87	1.24 (0.79–1.95)	157	76	1.15 (0.74–1.80)	154	76	1.12 (0.71–1.76)

*Adjusted for smoking, occupational dust and age.

†Adjusted for occupational dust and age.